Heliospheric Magnetic Field 1835-2010

Leif Svalgaard

Stanford University, CA

leif@leif.org

http://www.leif.org/research
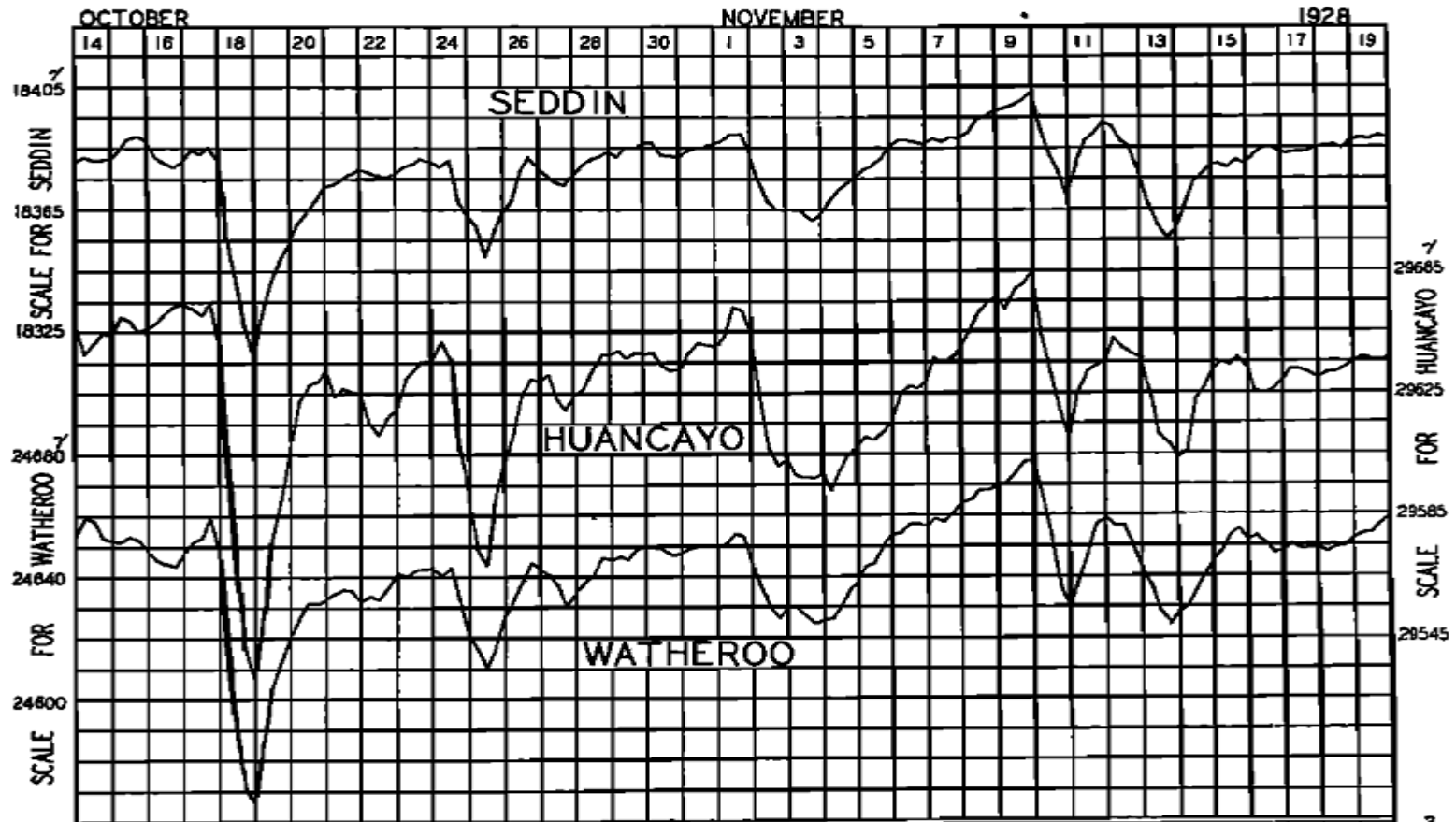
SORCE 2010, Keystone, CO, May 19, 2010

24-hour running means of the Horizontal Component of the low- & mid-latitude geomagnetic field remove most of local time effects and leaves a Global imprint of the Ring Current [Van Allen Belts]:
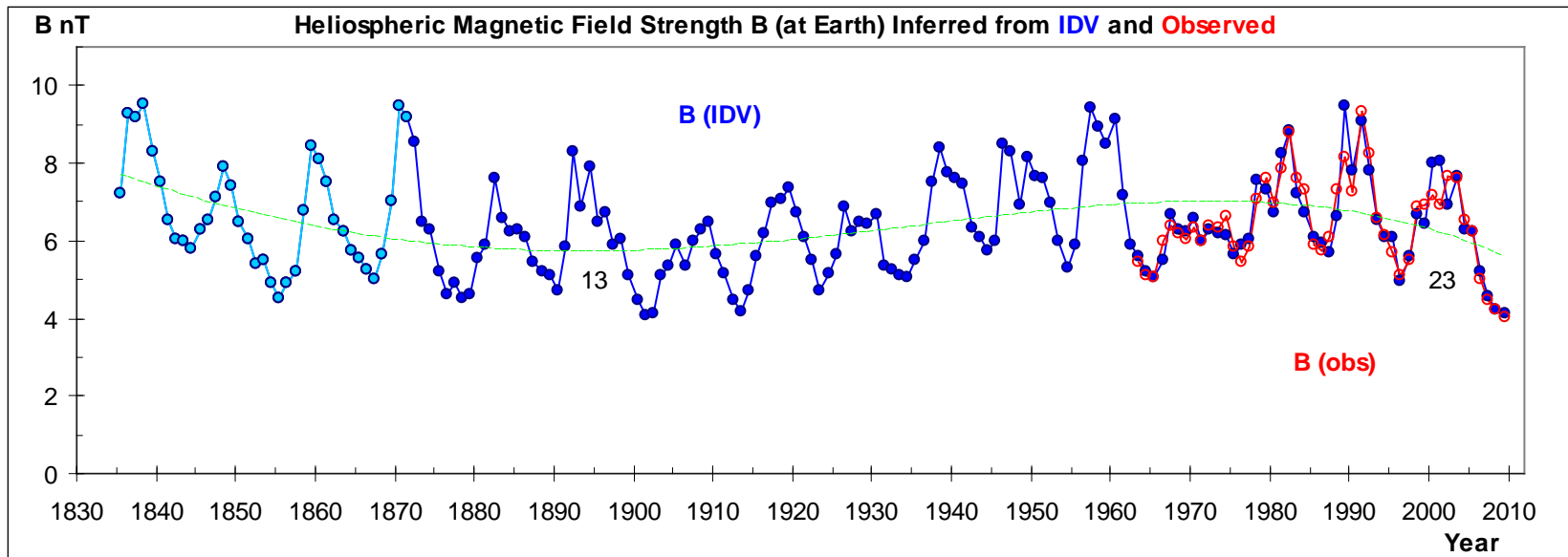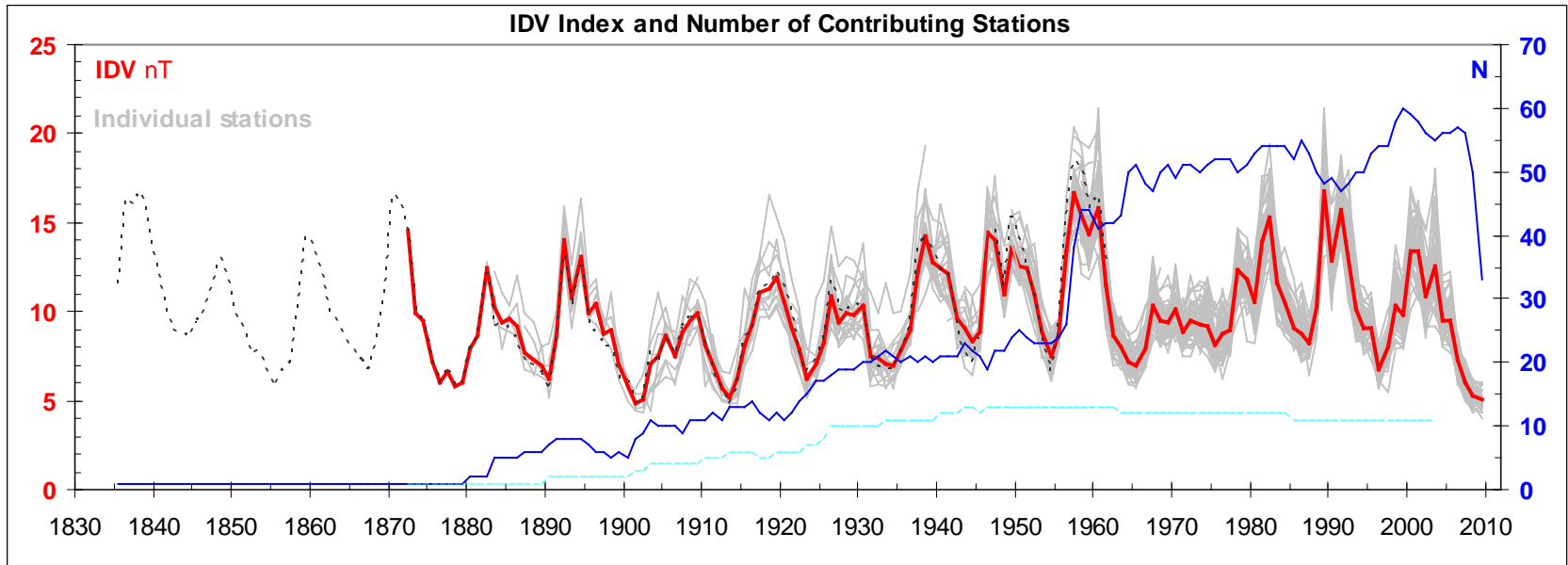

A quantitative measure of the effect can be formed as a series of the unsigned differences between consecutive days: The InterDiurnal Variability, IDV-index
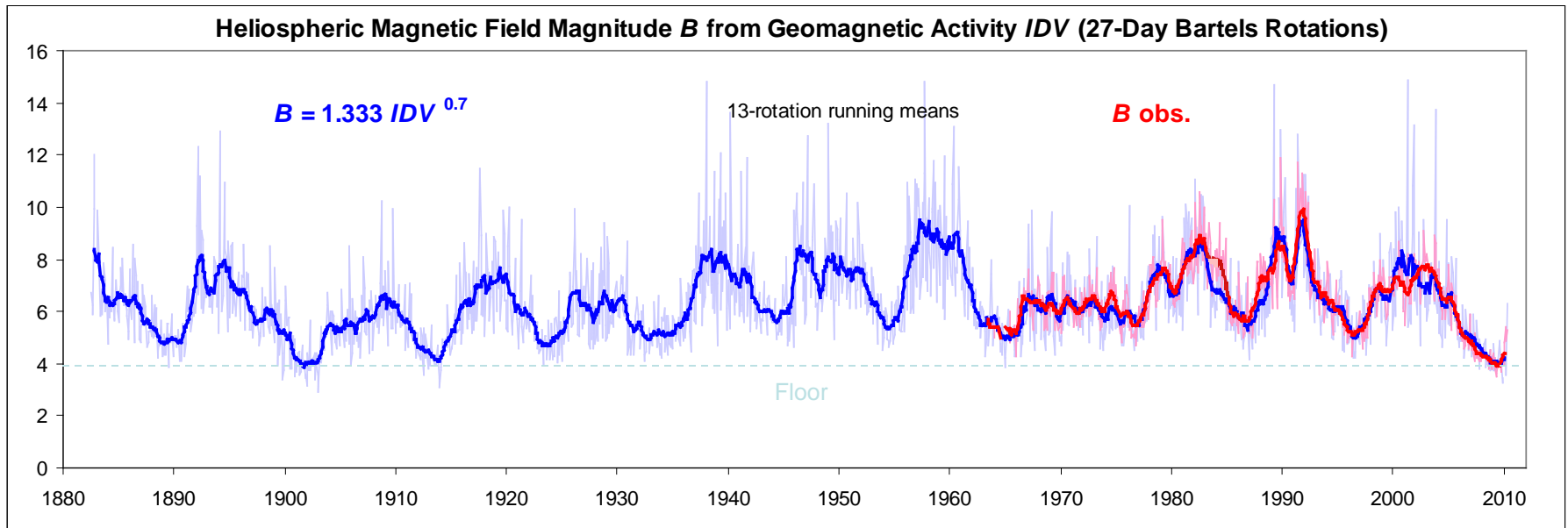
IDV is strongly correlated with HMF B, but is blind to solar wind speed V

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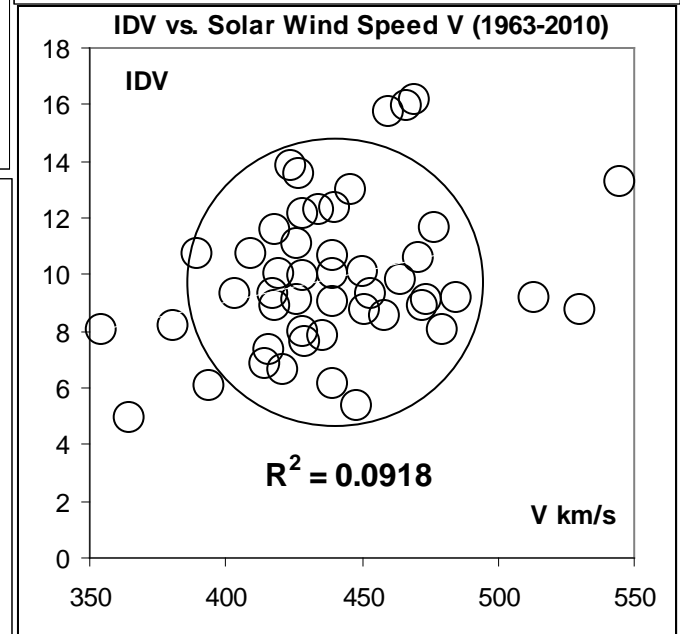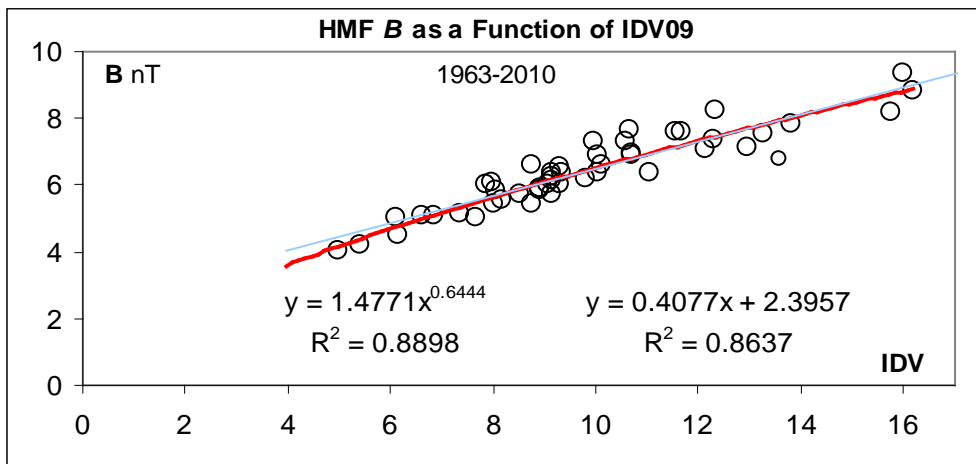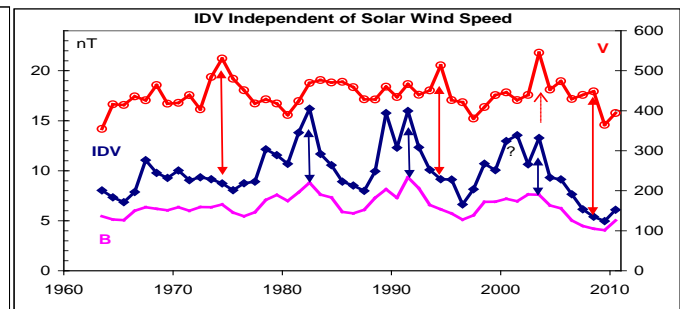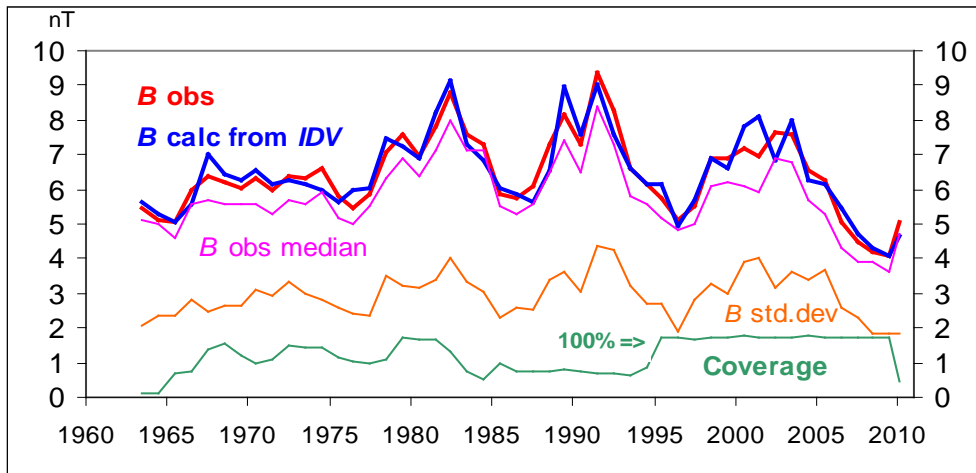
IDV and Heliospheric Magnetic Field Strength B for years 1835-2009

The previous Figures showed yearly average values. But we can also do this on the shorter time scale of one solar rotation:

Heliospheric Magnetic Field Magnitude _B_ from Geomagnetic Activity _IDV_ (27-Day Bartels Rotations)

$B = 1.333\ IDV^{0.7}$

13-rotation running means

_B_ obs.

Floor

The Figure shows how well the HMF magnitude B can be constructed from IDV. Some disagreements in the 1980s are due to the HMF being only sparsely sampled by spacecraft: in some rotations more than two thirds of the data is missing

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The negative part of the Dst-index is a measure of the strength of the Ring Current. IDV has an excellent correlation with Dst computed only from times when Dst was negative.
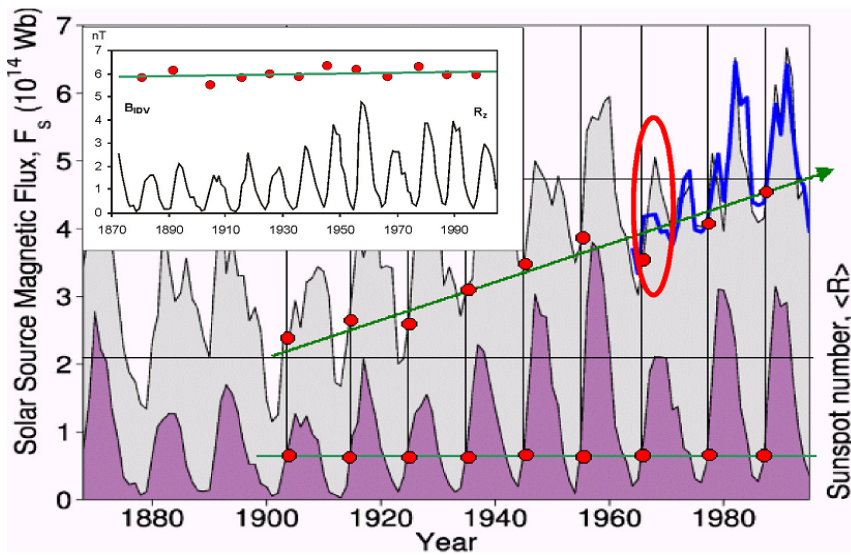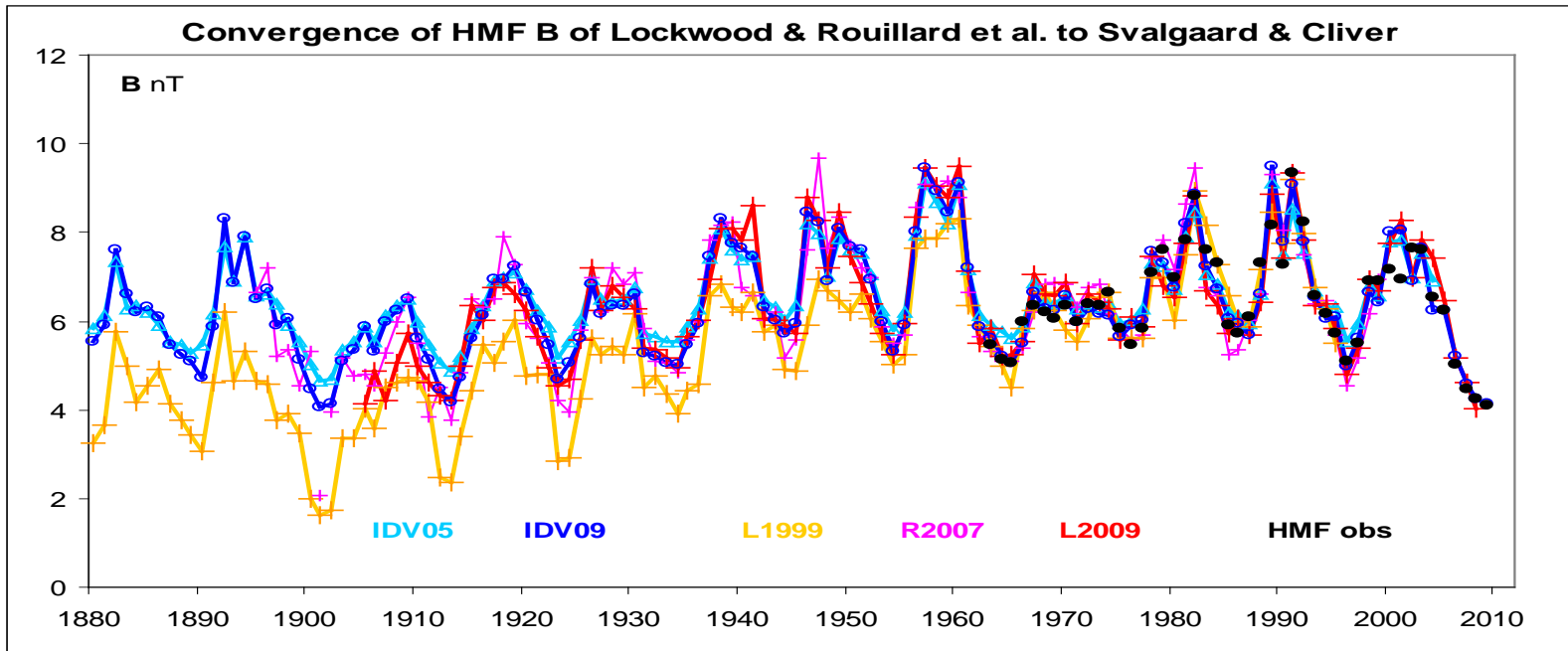
J. Love has reconstructed Dst back to 1905 using data from several geomagnetic observatories. For yearly averages: IDV = -0.45 [-Dst]

Negative D_{st} and IDV measure the same effect
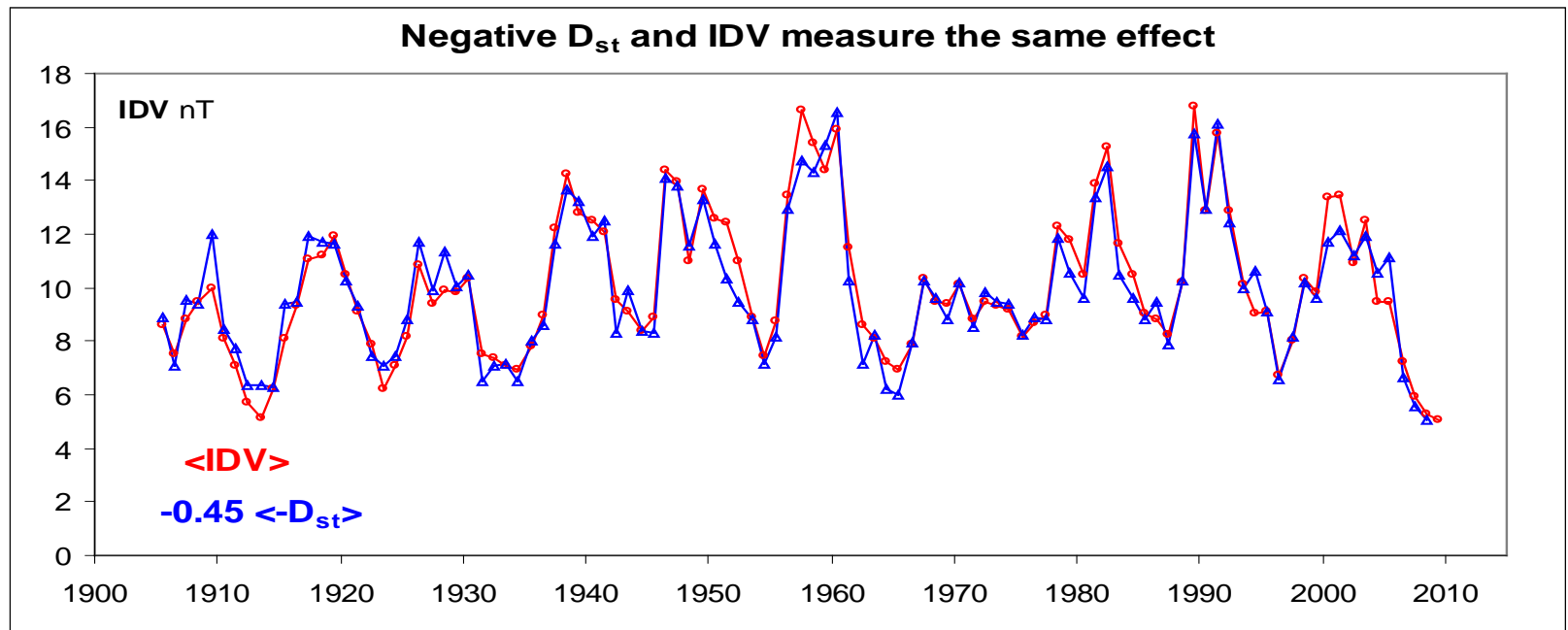
The HMF [and the 'open flux' calculated from B] has been controversial in the past, with claims of *a centennial doubling of the Sun's coronal magnetic field*. This is no longer the case. Several groups have converged to a firm consensus:


Convergence of HMF B of Lockwood & Rouillard et al. to Svalgaard & Cliver

IDV05   IDV09   L1999   R2007   L2009   HMF obs

Reconstruction of HMF B from cosmic ray modulation [measured (ionization chambers and neutron monitors) and inferred from 10Be in polar ice cores] first gave results [McCracken 2007] discordant from our geomagnetic method:

Heliospheric Magnetic Field Comparisons
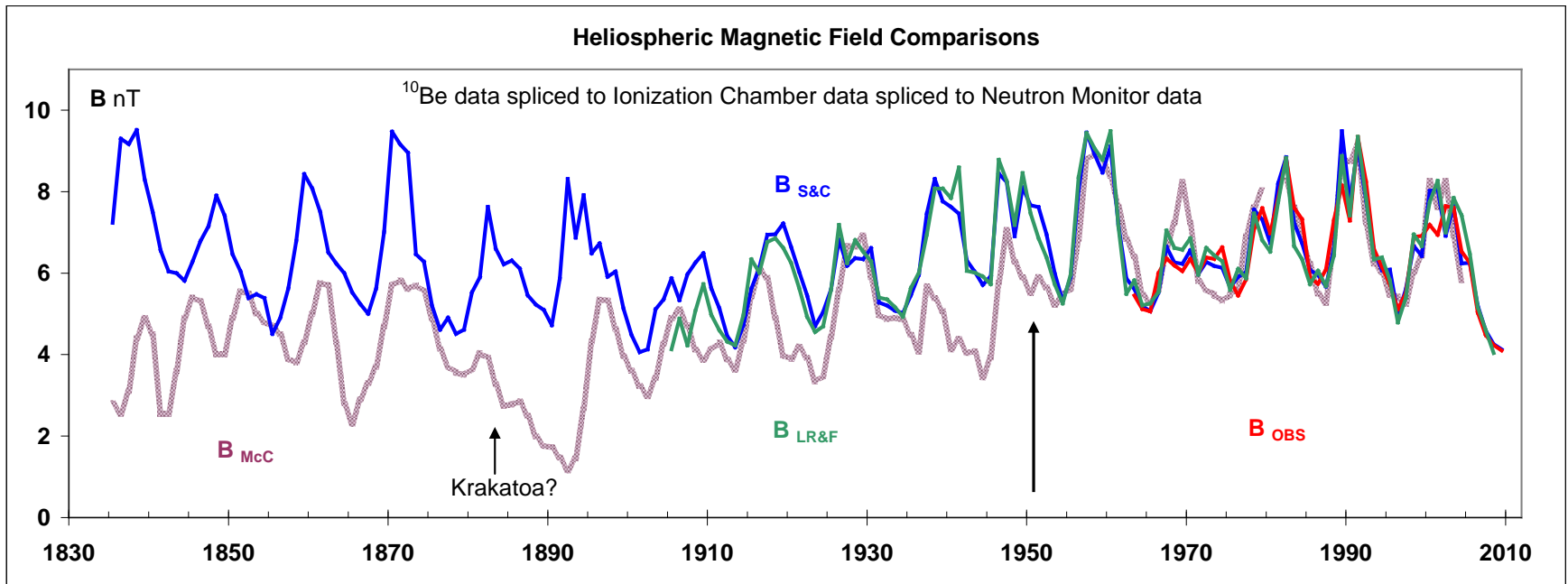
The splicing of the ionization chamber data to the neutron monitor data around 1950 seems to indicate an upward jump in B of 1.7 nT which is not seen in the geomagnetic data. The very low values in ~1892 are caused by excessive 10Be deposition [of unknown origin]

A reconstruction by Steinhilber et al [2010] on basis of 10Be agrees much better with ours based on IDV. The excessive deposition of 10Be ~1890 is still a problem for cosmogenically-based reconstructions [25-yr means]:
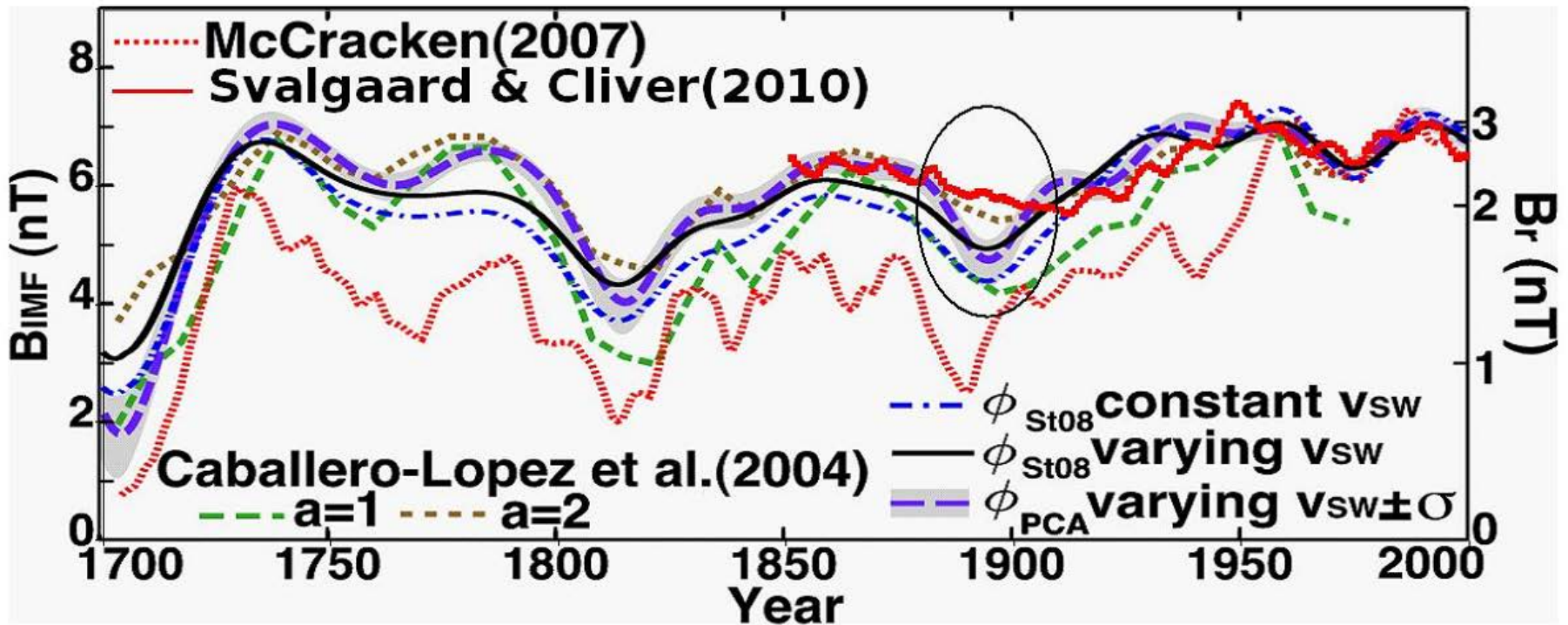

Webber & Higbie [2010] point out "those are most likely not solely related to changes in solar heliospheric modulation, but other effects such as local and regional climate near the measuring sites may play a significant role.

Since we can also estimate solar wind speed from geomagnetic indices [Svalgaard & Cliver, JGR 2007] we can calculate the radial magnetic flux from the total B using the Parker Spiral formula:

Radial Component of Heliospheric Magnetic Field at Earth
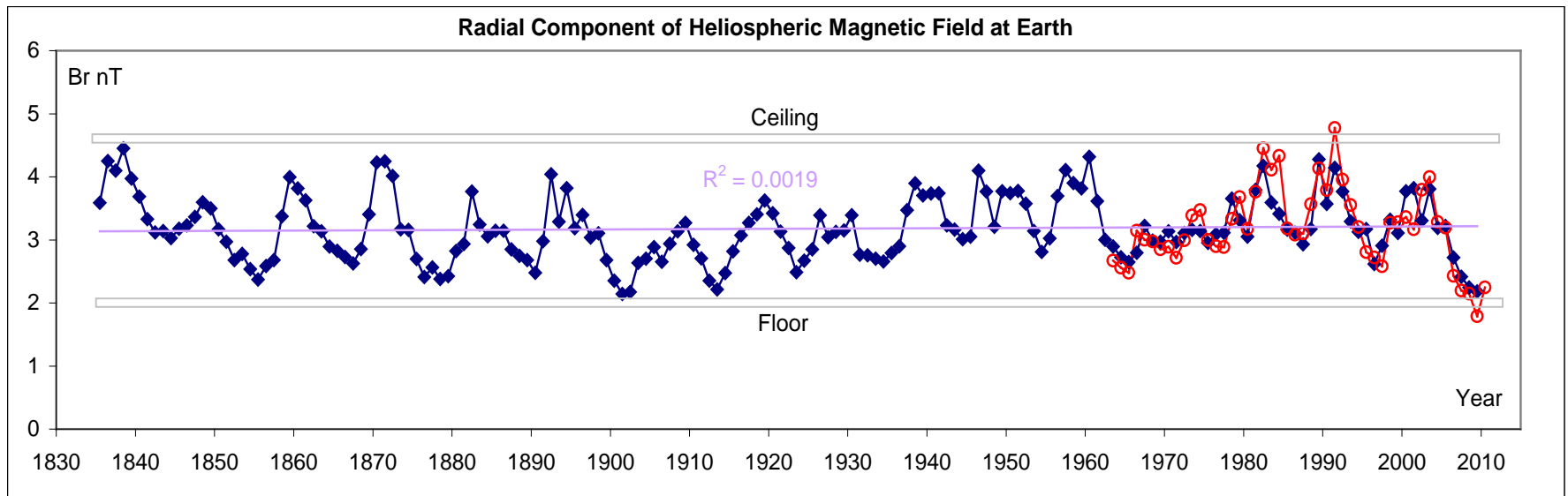
There seems to be both a Floor and a Ceiling and most importantly no long-term trend since the 1830s.

The absence of long-term trend probably means that there was no long-term trend in TSI as well:

TSI Reconstructions & Composites
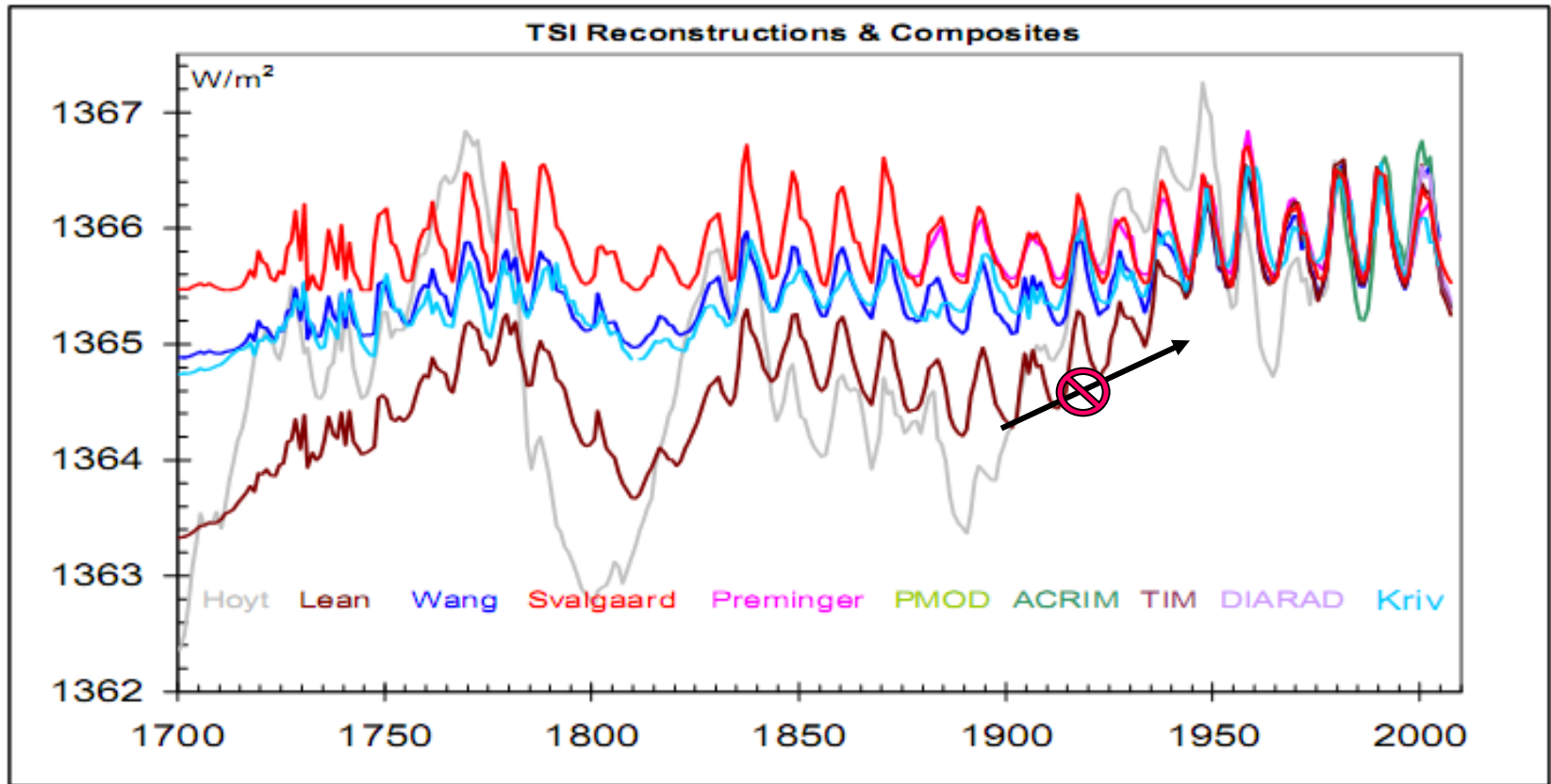
And that brings us within the subject of this meeting